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THE VIRGINIA
JOURNAL OF SCIENCE

VOL. 10, NEW SERIES JULY, 1959 No. 3

GINKGO BILOBA L: HISTORICAL SUMMARY AND BIBLIOGRAPHY

ALICELIA HOSKINS FRANKLIN
Washington, D. C.

HISTORICAL SUMMARY

GEOLOGICAL HISTORY.—*Ginkgo biloba*, the sole survivor of the family Ginkgoaceae, which in turn comprises the entire group or order Ginkgoals, represents a distinct plant form whose ancestry can be traced 200 million years or more into the past. Ginkgos evolved from the ancient seed-bearing ferns and first existed as small trees along the borders of the shallow seas. When the great Mesozoic Reptiles, among them *Brontosaurus* and *Diplodocus* lived in the shallow waters and fed upon the cycads, ferns and club mosses, the *Ginkgo* migrated to the tops of the gently rising hills, and grew to a height of 100 feet or more—too great for even an eighty foot dinosaur to reach. In this war between the destructive herbivorous reptiles and the plant life of their time, (a war which meant extinction for many other species) the *Ginkgo* survived. Through millions of years the ginkgos grew in the steamy forest atmosphere, living on somewhat higher ground than many of the early tree-like forms. The uplands of the Triassic and Jurassic ages became covered with ginkgo leaves bedded through endless generations and the trees still arched their enormous branches. In the Tertiary forests, the mammoth came and sharpened his tusks upon the trunk of the ginkgo tree, the sabertoothed tiger lurked in its shade and mice made their homes in its roots. Of early trees which survived the glacial period, F. H. Lamb (1938) states that the following are still in existence: two taxad cypresses (one living along the Gulf and South Atlantic coasts of the United States, the other the Montezuma Cypress of Mexico), the Giant Sequoias of California, and the Cryptomerias of East Asia and Japan; south of the equator other survivors include the podocarps, and the Kanri and Norfolk Pines of New Zealand, South Africa and the Pacific Islands.

From the Triassic to the Tertiary Period the ginkgos spread over most of the Northern Hemisphere and parts of the Southern. Warm

valleys in Greenland and Alaska became filled with enormous ginkgo trees. Ginkgo colonies were liberally distributed in Europe. Ginkgos were present in South America, South Africa, Australia, Asia and even Siberia. In America a few members of the ginkgo family thrived in what is now North Carolina, and they are widely distributed over what is now the Dakotas, Wyoming, Montana, Washington, and Oregon.

As the Triassic age came to a close more than 150 million years ago, the Ginkgoales boasted two large groups of the family, notably *Ginkgo* and *Baiera*. With the advent of the Jurassic we find other genera added to the growing family, increasing in volume through the Early Cretaceous age—genera which established themselves over a vast extent of territory both north and south of the equator. Only in Antarctica were there no Ginkgoales. At this time the ginkgo family was more widely spread than at any other era of its development, but during the Late Cretaceous its world wide distribution began to dwindle. The Cretaceous sea with its heavy concentrations of marine life flooded vast continents, and as a result the flora of the earth changed to a more modern aspect. A world-wide burst of evolution brought the angiosperms to prominence. *Ginkgo biloba* and only a few of its close relatives adapted to the chalky hills left by the calcareous oceans and survived the competition enforced by the new plant life. However, American, Artic, European, and Asiatic forests could boast of widely dispersed Ginkgo trees. During this time the Ginkgo gradually became restricted to the North Temperate Zone as a result of competition from neeotropical forests encroaching from the south.

During the Tertiary Period came a new threat. Great land upheavals accompanying the evolution of the Pyrenees, the Alps, and later the Andes mountains caused the great forests of *Ginkgo* to fall. New generations of *Ginkgo* took their places, but they were in isolated groups, separated by mountain chains, deserts and dry plains. In Oregon and Washington the rise of the Cascade Mountains cut off the summer moisture from the Pacific. This, combined with winter cold, hastened their end in this area.

At the end of the Tertiary Period a tremendous change took place in the northern continents. Cold gripped the world. Ice covered the northern latitudes extending into the temperate zones. In the face of these arctic conditions the ginkgos dwindled in number. Probably the Pleistocene was their last appearance in Europe. As the ice sheet moved southward with successive advances, the ginkgos gave ground, though they recovered lost valleys sporadically whenever the ice receded. Finally the ice completely overwhelmed these northern forests and swept all life before it far into the south temperate regions. The *Ginkgo* was unable to cross the Alps. In America the great cold preceding the ice sheets moved as far south as Philadelphia and California. If any stands of *Ginkgo* remained in the northwest they were unable to cross the Sierras

into California as *Sequoia* did. Thus they met extinction on this continent.

Only in East Asia, where the destructive ice halted in its southward progression, was the *Ginkgo* able to survive. Nestling in some warm secluded valley where it could migrate southward in those mountain chains where the ridges run in a northerly-southerly direction, *Ginkgo biloba* was spared complete extinction during the Ice Age. This sole survivor of a once numerous family retained its basic heritage through millions of years to appeal to the imagination of man, who with his cultivating hand would preserve this relic of an ancient past.

GENERAL DESCRIPTION.—Let us take a look at this deciduous, naked-seeded gymnosperm which so populated the earth at one time. *Ginkgo* in winter dress resembled the larch in general shape when young, with its slender pyramidal branching. When old its shape somewhat resembled that of the Douglas fir, especially in fastigate varieties, but in some cases it became spreading with a dense head. Individual trees could reach the age of 1,000 years, being surpassed in longevity only by the California Sequoia (3,500 years) and the Bristlecone Pine (4,600 years) *Ginkgo* stretched its branches higher than 100 feet and its girth exceeded 20 feet. Its bark was greyish, deeply furrowed on old trees. Branches whorled from the trunk at irregular intervals—some were erect and formed duplicate leaders. Branchlets drooped or were horizontal, continuing to produce short spur-like shoots for many years (as in larch or in cedar), and then suddenly lengthening out into long shoots. Sharp-pointed conical buds with bright brown scales terminated the short shoots which were crowded with leaf scars of past years. The branches in winter were a light golden brown.

In spring, leaves appeared in whorled clusters of six or less at the short shoots, and scattered along the length of the long shoots. The ends of the short shoots, and scattered along the length of the long shoots. The leaves varied from one to two or three inches in depth, and from one to three inches in breadth, with occasional exceptions up to six inches. In general aspect the leaf and stalk resembled a fan (the upper edge rounded, entire, irregular undulate, or bilobed). On vigorous young shoots the blade became dissected by V-shaped depressions into four or more wedge-shaped sections, and occassionally there were deeply cuneate leaves found in the seedlings or in new growth reviving from old roots, recapitulating the leaves of its ancestors. In spring these leaves were a light green, in summer a deeper glabrous leathery green, and in fall they turned a rich golden yellow before dropping in a clean and sudden fall.

In venation and shape these leaves appeared much like the leaves of the maidenhair fern or *Adiantum*. The two strands of connective

tissue from the forked veins in the stem radiated into the leaves, ending in numerous parallel veins which were interspersed with stomata and secretory cells exuding a sticky fluid.

On trees of twenty years or more, flowers appeared in May. The male blossoms were small, pendulous catkins on the short stalks, three to six upon a shoot, bearing loosely arranged stamens. The female flowers (mere naked ovules) emerged from the short shoots in pairs of two or three, growing to stand erect upon their long stiff stalks rimmed at the juncture by a collar. The pollen blew across the forests thick and yellow, depositing itself upon the sticky ovule for the propagation of a new generation. In time a small plum-like fruit, containing a hard-shelled nut with a kernel, developed upon the stalk. The fruits in turn fell to the ground in early September giving off a most offensive odor. In the fall two spermatozoids developed from the pollen within the ovule, swimming in a sac of simulated sea water, to fertilize the egg cell. The developing embryo within the seed lay where it fell in the woodland duff, or was planted by small animals in the woodland loam. In spring two cotyledons followed by five cuneate leaves appeared on the ground underneath the big old tree's shade. Sometimes the ancient trees would produce peg-like structures (air roots) from the trunk or lower branches, which would produce true roots upon touching the ground, and then produce branches above it. Sometimes the old tree died and the new sprouts took its place. Generation followed upon generation for millions of years with virtually no change in the *Ginkgo biloba*.

GINKGO IN THE ORIENT.—In some remote valley of the forests of China, the *Ginkgo biloba* overstayed its time. Although its ancestors had covered the entire world, this remnant of one of the "first families" of trees now remained hidden from those who sought its native habitat. Some reported seeing it in the wild state. Mrs. Bishop (Bird, 1880) traveled widely in the Orient at the end of the last century and reported that she had seen it growing natively in Japan in the great forests of the northern island Yezo, and also in the country at the sources of the Great Gold and Min Rivers in Western China. The foresters of Japan denied however that the *Ginkgo* was indigenous to that country in historic times, maintaining that it was introduced from China, perhaps by the Buddhist monks, about a thousand years ago.

E. H. Wilson (1913), travelling for the Arnold Arboretum fifty years ago believed that the *Ginkgo* no longer existed in the wild state. His travels, though extensive in range, followed the main river valleys, and were intensive in the area of Lushan in Northern Kiangsi in eastern China, and in western China in western Hupeh and Szechuan. His itinerary barely missed the stand of truly wild *Metasequoia*, another rare remnant from before the Ice Age. Perhaps he missed the Ginkgo also.

Yet another botanical explorer for the Department of Agriculture, Frank Meyer, travelling for the discovery of useful native plants of China, searched the southerly approaches to the Chinese mountains while Wilson was exploring the more northerly sector. He maintained that the *Ginkgo* grew spontaneously (according to Wilson, 1913) near Hsien, about 70 miles west of Hanchow, in the Chekiang Province of China, where he reported the *Ginkgo* was so common that it was cut for fire wood. Whether this stand of *Ginkgo*, lying in the Tien Mu Shan Range, along the northwestern border of Chekiang and Southeastern Anhwei and attaining a topmost altitude of 5,000 feet, represented the last wild *Ginkgo* cannot now be verified, since the prodigious accumulation of population and resulting cultivation in China has meant depredation of the wild forests.

However, there were Chinese who collected *Ginkgo* in this area, also in the mountains of southwest Kweichow and Szechuan, and believed that it grew spontaneously, in association with conifers and broad-leaved trees. This area of Chekiang, according to Hui Lin Li (1956) is the habitat of some other relic plants, among them *Pseudolarix* and *Nothotaxus*. *Torreya grandis* and *Carya cathayensis* also occur in this region, as do the semi-wild and cultivated Ginkgo. So possibly it was in this region that *Ginkgo* was finally preserved from extinction and later cultivated by the ancient Chinese who used the nuts for food. Certainly this is the region from which all our cultivated trees of today have been derived.

In these mountain fastnesses far from habitation it attains a height of over a hundred feet. It is also found in the vicinity of temples and private gardens where the native plants have been preserved, and is a very common tree in an area where primeval forests no longer exist.

Ginkgo may have been known to the populace of Kiangsu and Anhwei during the Tsin Dynasty (240-420 A.D.) and has been attributed the name of P'ing Chung Kuo in poetical essay by Wu Tu Fu.[1]

According to Bretschneider, all plants mentioned in the literature before the first century, B. C., can be presumed to have originated in China, as there was no possibility of communication with the outside world at that time. It was still some centuries before the Chinese traded as far south as India.

Bretschneider also states that a single character in Chinese indicates antiquity, thus of the name Yin Sing (Silver Apricot) for the *Ginkgo*, the single character for Apricot is of ancient origin. The name Ya Chio (leaf

[1]According to botanists Li Shih-chen in 1956, and Wu Chi-chum in 1948 who studied this literary work.

of a Duck's Foot), is perhaps older, since it appears to have originated the southern provinces, the native haunt of *Ginko*. The earliest civilization of the Chinese flourished in the north of China along the Yellow River and although many indigenous plants are mentioned in the early literature of this period in North China apparently *Ginkgo* is is lacking. Since Ya Chio is written in two or sometimes three idiographs, it indicates a later introduction from the South.

During the Sung Dynasty of the eleventh century there are many records of this tree in cultivation along the Yangtze River. It has been reported by Hui Lin Li (1956) that a Sung notebook entitled "Shi Hua Ching Duei" proclaimed: "In the Capitol (Kaifeng) there was originally no Ya Chio (Duck's Foot). Since Prince Li Wen-ho came from the south and transplanted it to his residence, it becomes famous. From then it gradually propagates and multiplies, and fruits from the south are no longer considered precious."

As a result of early Chinese agriculture, many botanical works were published in medieval times. A medicinal use for early plants was subscribed to in many instances. *Ginkgo* seed eaten raw has been touted as an expectorant and as a cure for cancer. However, the toxic effects of the raw seed sometimes prove to be fatal. One herbal by Wu Jui called "Jih Jung Pen Ts'ao" recounts that even the cooked nuts if eaten in excess, especilly by children may prove to be slightly toxic. In spite of this warning note, the *Ginkgo* was extensively cultivated as a source of food, and was considered a delicacy when roasted for festive occasions.

The peoples of the orient have used the *Ginkgo* in the preparation of a kind of cosmetic when the seeds are soaked in wine. The Chinese even use the seed pulp combined with lye as a soap to wash clothes. It has wood uses of a very limited sort as the grain is much like white pine. Abacus beads have been made from it; chessmen also. It is widely used as the base for fine oriental lacquerware.

According to some early botanical records the Chinese were aware that *Ginkgo*, which is dioecious with pistillate and staminate reproductive organs on separate plants, should be planted with the two kinds together to insure fruiting. But other early records stated that the female tree when planted alone beside water would produce seed. This may be ascribed to the fact that the ovule develops much starch even without fertilization. Grafting of a male branch upon a female tree was also practiced as a method of insuring the crop. Seed shape was considered to be a sex determinant. Those seeds with three ridges on the two-pointed nut were supposed to yield male trees, while those with two were supposed to yield females. The accuracy of this belief does not appear to have been demonstrated, as three-sided Ginkgo nuts are rare.

The *Ginkgo* was also planted for its aesthetic value, being trans-

planted and cared for in private gardens and temple grounds, often perched on some mountain crag, adding an aura of charm to the temples. In time it became known as the sacred *Ginkgo*. Lengthy legends grew up around the old tree, for the people of the orient have revered and preserved these *Ginkgo*, decorating them as shrines with incense stands. The temple grounds provided a sanctuary for the *Ginkgo* along with much of the indigenous flora of the orient, since the Buddhist and Taoist priests preserved the forests surrounding their temples. Consequently there are *Ginkgo* trees of enormous size in many venerable temple enclosures.

The temple tree, *Ginkgo*, is next found to be introduced into Japan. Although the exact date is unknown, some have supposed it was imported with Buddhism, or at least to have come to Japan by the end of the Sung Dynasty of the eleventh century. Japanese botanists assume a minimal date of 1,000 years residence for *Ginkgo* in Japan, since there are living specimens of approximately that age at the present time.

In Japan, the *Ginkgo* leaves are ground for fertilizer, and are used as an insecticide when spread around the base of plants. School children place *Ginkgo* leaves in their books "to scare the worms away." Young girls' hair styles and artists' designs derive inspiration from the shape of the leaf. *Ginkgo* is woven in many ways into the pattern of oriental life.

GINKGO IN THE WESTERN WORLD.—Ginkgo first becme known to the western world when Dr. Englebert Kaempfer, a ship's doctor in the employ of the Dutch East India Company, searched the Far East during his extensive travels for a tree which he had previously seen in Japan in 1690. It is believed that he obtained the tree in south China, and brought it back to Holland. Perhaps it became the famous old *ginkgo* in the Botanical Garden at Utrecht.

He published a description of it in his *Amoenitatum exoticarum* (1712), containing a drawing of a leafed branch with ovule. He called it "*Ginkgo* vel Ginan, vulgo Itsojo, arbor nucifera folio adianto."

There has been much speculation as to the origin of the name *Ginkgo*, since there is no word corresponding exactly to this spelling in either Chinese or Japanese literature. Kaempfer's fifth and last fascicle of his work *Amoenitatum exoticarum* introduced the name as indicative of the Chinest literary idograph for Yin Sing (Silver Apricot) as pronounced in Japan. The Rev. Dr. A. C. Moule, a Professor of Chinese at Cambridge University has pointed out that there are no grounds for the termination -kgo, which is "unpronounceable and probably ought never to have existed." In all probability it is a misspelling of the word Gin-yo or or Gin-go of South Chinese origin meaning Silver Apricot, the -kg of the

word ginkgo becoming attached in the process of transliterating the word into Dutch, perhaps the work of Kempfer or one of Kaempfer's assistants.

In 1771 Gorden sent a sample of the leaves to Linnaeus, who included it in his publication *Mantissa plantarum*. To Kaempfer's "*Ginkgo*", which he adopted as the generic name, he added the specific name of "*biloba*" as descriptive of the leaf form which he obtained.

Twenty-six years later, J. E. Smith (1797) in a paper before the Linnaean Society, renamed the tree *Salisburia adiantifolia*. A few authors subsequently wrote papers under this title, but the accepted nomenclature of Linnacus prevailed in spite of Smith's contention that the word ginkgo was "Equally uncouth and barbarous." To this day the *Ginkgo* is known as the Maidenhair Tree in England—a name derived from the form of its leaves which resemble the Maidenhair Fern— the *adiantifolia* of Smith

The tree has been called *Ginkgo*, as a preferred spelling, by the London *Times* in a series of articles and correspondence in February and March in 1946. The *New York Times* and *The New Yorker* have used the plural "*Ginkgoes*"—in a facetious manner (because of the periodic rash of ill-smelling fruits upon the sidewalks during fruiting season). *Ginkgo* is also the spelling found in official usage by the United States Department of Agriculture.

In French literature, reference is often found among the older publications to the "arbre au quarante ecus," referring to the price a M. Petigny paid a nurseryman in England in 1780 for five *Ginkgo* seedlings which he took to France.

Most of the early trees in Europe proved to be staminate trees. De Candolle recorded the first fruiting tree in Geneva in 1814, and was instrumental in having scions grafted on the trees in the Botanic Garden in Montpellier, France, where first permanent seed was produced.

As far as the records show, the *Ginkgo* was first introduced to the United States by William Hamilton, who planted a tree in 1784 in what is now Woodlands Cemetery, West Philadelphia. Although this tree died a fews years go, one of comparable age in John Bartram's Garden in Philadelphia is still thriving.

Since the Ginkgo is free from serious pests and diseases, is not particular as to soil, and shows a marked tolerance to city smoke and industrial fumes, it is becoming known as a fine street tree, reaching a height of 40-80 feet. It flourishes particularly in Washington, D. C., and other locations where the climate fulfills the *Ginkgo* requirement for moisture (35 inches of rainfall) and warm nights during the growing season. With sufficient watering, however it grows well in most of the country.

Ginkgo is distributed over all but the coldest states of the north central

United States, where winter cold and limited rainfall fail to provide even minimal conditions. It grows only slowly in the northwest states, which may account for the discrepancy in the literature as to its rate of growth. In the latitude of Chicago or even New York, seedlings will not withstand the winter temperature, but must be protected in a greenhouse. Cuttings will survive in an exposed situation more readily, as will grafted stock. Both of the latter methods of propagation are required when staminate trees or specific varieties are demanded for street planting. Under cultivation, this tree now grows in many countries in the temperate latitudes where it once grew natively before the Ice Age.

HISTORY OF CLASSIFICATION.—The genus *Ginkgo* was included, under Coniferae in *Die Naturlichen Pflanzenfamielien*, in the Taxae with *Taxus*, *Cephalotaxus* and *Torreya*. Eichler had previously referred *Ginkgo*, or *Salisburia* to a separate family—the Salisbureae. The most remarkable botnical event in the late 19th century then occurred. Hirase, a servant in the laboratory of Matsumura in Tokyo, asked his master for a problem in botany, since he had learned the use of a microscope. Recalling that the reproductive mechanism of *Ginkgo* had yet to be determined, his master referred Hirase to the *Ginkgo* tree outside the door. Hirase's discovery in 1896 of the motile antherozoid in the pollen tube of *Ginkgo* confirmed a growing suspicion among taxonomists that the classification of *Ginkgo* with *Taxus* and other Coniferae was no longer consistent. Following this discovery Engler adopted the family name *Ginkgoaceae*, and further isolated its position by placing it in the special class of Ginkgoales.

Dallimore and Jackson list the varieties of *fastigata* (columnar in form with branches erect), *macrophylea laciniata* (with leaves larger and more deeply cut), and *variegata* (whose leaves are variegated with yellow). Other varieties have sometimes been named, or differentiated and again disputed.

EPILOGUE

Ages before a unique creature called man discovered its usefulness, and made it his original nut tree, the *Ginkgo* inherited the earth. In a world comprised of mountains where there are now valleys, and water where there are now hills, prior to the formation of the Rockies and the Urals, it demonstrated everywhere its extraordinary vitality, adaptability, and resiliency to the changing environment. In times of temporary drought it preserved its cellular structure enough to revive—coming up from the roots when otherwise appearing dead. It receded here to revive again elsewhere. It crossed the temporary land bridge between Asia and America by way of Alaska and Siberia, and possibly another land bridge between Asia and America by way of Greenland and Franz Joseph Land. In general it liked a moist humid climate but could withstand temporary searing by fire. Its trunk with bark which has been compared to an elephant's skin, was pro-

tection against marauders both animal and insect. The leaves were not bothered by insect pests, and the wind carried the pollen from male to female tree for thousands of generations.

The great enigma in the investigation of *Ginkgo* still hinges around the problem—the innate question—of how the *Ginkgo* survived the vicissitudes of the passage of time for millions of years during the rise and fall of countless genera upon the face of the earth. Time and its relationships lose meaning for the human mind in the face of such a survival, and some fundamental facts of paleontology find an exception in the reading of the record of *Ginkgo*. *Ginkgo biloba* L. indeed has a preeminent claim to be designated in Darwin's words "a living fossil."

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This bibliography was compiled for the University of Virginia with funds provided by Mr. John Lee Pratt under the supervision of Dr. Randolph T. Major of the Cobb Chemical Laboratory of the University, and with the encouragement of Dr. Ladley Husted of the Biology department of that University.

The bibliography encompasses all aspects of the literature of the living *Ginkgo* from the more general paleobotanical and historical works to the research investigations on taxonomy, morphology, reproductive system, cytology, chemistry, pharmacology, and horticulture, which are obtainable in Washington, D. C.. It includes the research published during the years of 1880 to the summer of 1958, and lists only those earlier works of particular historical interest. For extensive bibliographies of the 19th century investigators, consult A. Seward and J. Gowan, *The Maidenhair Tree*, Annals of Botany, London 1900; and A. Specher, *Ginko biloba* L., Geneva, 1907. Unpublished material may be found in the Hill Culture Section Reports of the Pre-World War II Soil Conservation Service of the U. S. National Archives. The Plant Science Catalogue of the Department of Agriculture lists 141 publications on the *Ginkgo biloba* which are included in this bibliography.

Dr. Samuel Detwiler, retired, and Miss Doris Hayes of the Department of Agriculture; Mr. Oliver Shipley and others of the Staff of the Department of Agriculture Library; Dr. Roland Brown of the Geological Survey were of great help, as were Mr. Wm. V. Heers and Miss Guerry Newton of the Geological and Paleobotanical Libraries. The Orientalia and Science Sections of the Library of Congress were also of assistance. Miss Marie Siegrist of the Geological Society of America Bibliographic Staff gave encouragement.

A number of papers written in Japanese have been translated by Dr. Joseph Yoshioka of Bethesda, Maryland, and a number of those in

French and German by the author. These translations, together with a set of notes and abstracts, may be obtained from the author by those wishing to pursue research on the *Ginkgo*.

It is hoped that this historical background and the following bibliography will aid investigators studying the *Ginkgo*, and that further research will provide new information on the reasons for its survival.

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A PRELIMINARY REPORT ON AN OCCURRENCE OF CAMPOSTOMA ANOMALUM (RAFINESQUE) IN THE YADKIN RIVER DRAINAGE SYSTEM

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A new record of *Campostoma anomalum* (Rafinesque) from the Yadkin River drainage system was taken in a collection (RDR No. 802) made by R. D. Doss, Kenneth Cook, and Jerry Wakeman, July 16, 1957, from Johnson Creek, 3.5 miles SE of Fancy Gap in Carroll County, Virginia. This appears to be a race of the New (Upper Kanawha) River campostomid tentatively described as *kanawhanum* Ross, 1952, and published as a *nomen nudum* (Ross, 1958). It also shows some relationship to the Roanoke and James River campostomids published as *virginianum* (Ross, 1958, *nomen nudum*) and tentatively described as *roanokense* (Davis, 1953). It shows some parallelism with the Santee River sub-race of *C. A. anomalum* described by Ross in 1952. The Yadkin, Roanoke, and James River forms, however, are probably best regarded as races of the undescribed New New River form.

The Yadkin and New River forms show a relationship in six characters, (1) number of scales in the lateral line, (2) number of scales around caudal peduncle, (3) number of scales from lateral line to lateral line across the back anterior to the dorsal fin, (4) number of scales anterior to the dorsal fin, (5) number of scales below lateral line from origin of anal fin plus number of scales below lateral line from base of pelvic fin, and (6) number of scales below lateral line to anal plus number below lateral line to pelvic, plus number of scales around caudal peduncle. (Tables I, II and IV). In two characters, number of lateral line scales and number of caudal peduncle scales, this relationship is very close. The Yadkin and Roanoke River races approach each other in these characters and in the characters: (1) number of scales from lateral line to lateral line across anterior to the pelvic fins, and (2) number of scales in lateral line plus number of scales around body. The Yadkin specimens show no significant relationship with the other forms in number of scales around body minus the number of scales around the caudal peduncle (Table I), and it is believed that the correspondence which appears between the Yadkin and Santee forms in the number of scales around body plus number of lateral line scales (Table III) is due to parallel evolution.

This record provides biological evidence for Wright's (1931) suspected stream capture from the New River drainage in the Hillsville area, and

lends credence to Evermann's (1916) record of *Campostoma anomalum* from the Lumbee (Lumber) River of Yadkin drainage in North Carolina. It is hoped that further collections will provide more specimens for study and that a more complete report on the Yadkin campostomids can be made at a later date.

ACKNOWLEDGEMENT

The author is most grateful to Dr. R. D. Ross for making available his collection of the Yadkin campostomids for study, for permitting use of his data concerning the New and Santee River forms and for his advice and guidance concerning this study. Also, I wish to thank Mr. W. S. Davis for giving his permission to use data from his unpublished thesis.

TABLES I-IV. SCALE NUMBERS IN *Campostoma anomalum* FROM DIFFERENT COLLECTING SITES

TABLE I

Forms From:	Number	Range	Mean	σ	σM
		Lateral Line Scales			
Yadkin River	23	47-56	50.9	2.4	0.50
New River	350	43-58	50.6	2.4	0.13
Roanoke River	53	45-55	49.4	1.8	0.25
Santee River	68	46-57	50.1	2.1	0.26
		Scales Around Body			
Yadkin River	23	35-42	39.6	1.79	0.37
New River	334	40-56	48.1	3.2	0.17
Roanoke River	53	39-52	45.1	3.6	0.29
Santee River	68	33-51	40.8	2.7	0.33
Scales Below Lateral Line to Anal Fin Plus Scales Below Lateral Line to Pelvic Fin Plus Caudal Peduncle Scales					
Yadkin River	23	32-40	36.4	1.76	0.37
New River	141	30-48	39.6	3.5	0.30
Roanoke River	44	32-39	35.0	3.0	0.44
Santee	68	31-37	34.2	1.3	0.15

TABLE II

Forms From:	Number	Range	Mean	σ	σM
Lateral Line to Lateral Line Across Back					
Yadkin River	23	16-19	17.2	0.88	0.18
New River	256	16-23	19.1	1.2	0.08
Roanoke River	53	16-23	18.3	1.3	0.18
Santee River	68	15-18	16.3	0.90	0.11
Scales Around Caudal Peduncle					
Yadkin River	23	20-24	21.5	1.3	0.27
New River	192	18-23	22.3	1.6	0.12
Roanoke River	53	16-23	19.9	1.2	0.16
Santee River	69	19-23	20.4	0.8	0.10
Scales Around Body Minus Scales Around Caudal Peduncle					
Yadkin River	23	14-21	17.96	1.7	0.35
New River	136	17-34	25.6	3.2	0.28
Roanoke River	53	19-31	25.2	3.3	0.45
Santee River	68	14-26	20.1	2.5	0.30

TABLE III

Forms From	Number	Range	Mean	σ	σM
Scales Around Body Plus Lateral Line Scales					
Yadkin River	23	85-98	90.5	3.6	0.74
New River	343	86-111	98.8	4.5	0.24
Roanoke River	53	85-113	94.5	4.6	0.63
Santee River	68	83-99	90.5	3.2	0.39

TABLE IV

Forms From:	Number	Range	Mean	σ	σM
Scales from Lateral Line to Lateral Line across Belly					
Yadkin River	23	20-25	22.3	1.3	0.27
New River	253	19-35	26.9	2.7	0.17
Roanoke River	53	20-33	25.1	2.4	0.33
Santee River	70	19-27	22.2	1.9	0.23
Scales Anterior to the Dorsal Fin					
Yadkin River	23	20-27	23.4	1.6	0.32
New River	148	22-29	25.2	1.6	0.13
Roanoke River	44	21-28	24.3	1.5	0.22
Santee River	69	19-26	21.5	1.3	0.15
Scales Below Lateral Line From Anal Fin Plus Below Lateral Line From Pelvic Fin					
Yadkin River	23	13-16	14.5	0.78	0.16
New River	207	12-21	15.8	1.5	0.11
Roanoke River	44	11-24	15.2	2.1	0.32
Santee River	69	12-17	13.9	1.1	0.13

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THE TUBE PRECIPITATION TECHNIQUE AS APPLIED TO THE STUDY OF SEROLOGICAL RELATIONSHIPS AMONG CRAYFISHES[1]

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Much of our knowledge of serological systematics has been gained from the work of Dr. A. A. Boyden and his students at Rutgers University. An excellent review and critique of the methods and goals of comparative serology has recently been published (Boyden, 1958). Using the tube precipitation method with the hemocyanins of the Crustacea as antigens, it has been found that the serum proteins of members of a given genus are serologically more similar to one another than they are to members of other related genera (Leone, 1949). The hemocyanins of some of the crayfishes have been investigated by Leone and Pryor (1952); five species of crayfishes of the family Astacidae and five species of the Australian crayfishes of the family Parastacidae were compared. Results showed that species within the genus *Orconectes* (family Astacidae) are closely related. Within the family Parastacidae, the genera *Cherax* and *Euastacus* differ serologically but are more closely related to one another than to species of the family Astacidae.

The present study was undertaken in order to shed more light on the taxonomic relationships among members of the genus *Cambarus* (family Astacidae). Since it is difficult to distinguish intrageneric difference serologically, members of the genera *Orconectes*, *Procambarus*, and *Pacifastacus*, family Astacidae) were included in order to determine the specificity of the antisera prepared.

MATERIALS AND METHODS.—The Crayfishes belonging to the genus *Cambarus* which were used in this study have been assigned to three groups; *Cambarus bartonii bartonii* (Fabricius), *C.b.sciotensis* Rhodes, *C. b. robustus* Girard. *and C.b.*subsp. of the Bartonii group; *C. montanus acuminatus* Faxon of the Montanus group; and *C.longulus longulus* Girard, *C.l.longirostris* Faxon, and *Cambarus* species of the Longulus group.[2]

Four species of the genus *Orconectes*. [*O.juvenilis* (Hagen), *O.nais* (Faxon), *O.immunis* (Hagen) *and O.propinquus* (Girard)], two species of the genus *Procambarus* [*P.clarkii* (Girard) and *P.blandingii acutus*

[1]This investigation was supported by a National Science Foundation Award during the summers of 1956 and 1957 at the Mountain Lake Biological Station in Giles County, Virginia.

[2]Personal communications from Dr. Horton H. Hobbs, University of Virginia who also identified the crayfish.

(Girard)], and one species of the genus *Pacifastacus* [*P.trowbridgii* (*Stimson*)] were included.[2]

The crayfish sera were collected and the antisera prepared in the same manner as reported by Johnson (1957).

The Libby photronreflectometer was used to record the turbidities in a series of tube precipitations. The sensitivity of this instrument has been established by Boyden, Bolton and Gemeroy (1947), and Bolton, Leone and Boyden (1948).

The procedure utilized in these tests was essentially the same as that of Leone (1949). The volume of antiserum was constant while the volume of antigen (crayfish serum) was varied (alpha precipitation).

Data for serological comparisons were obtained by a summation of the turbidity units, a value proportional to the area under the curve. Such a summation of the turbidities produced by an antiserum and its specific antigen (homologous curve) is the standard of comparison between that antiserum and any heterologous antigen. This summation is arbitarily assigned a value of 100 percent (Boyden, 1954.)

The tests combining the various antigens and antisera were run three times unless otherwise noted in Table I and the standard deviation from the mean computed.

RESULTS.—Table I shows the results of interaction of the crayfish antigens with the antisera prepared. The numbers represent the percent correspondence of the various antigens tested with the anti-serum indicated. These figures are the mean percent of three series of tests (except for those with an asterisk).

It can be seen that the members of the genus *Cambarus* are closely related and, because of the standard deviation of some of the tests, cannot be considered significantly different. With all of the antisera prepared against the members of this genus, significant differences between them and members of the genera *Orconectes*, *Procambarus*, and *Pacifastacus* were demonstrated. A notable exception was the antiserum prepared against *Cambarus* sp. and the unexplainable reaction between the antiserum prepared against *C.b.robustus* and the antigen of *P.trowbridgii*.

The results of the tests utilizing the antiserum prepared against the serum of *O.juvenilis* may be interpreted as indicating that the members of the genus *Orconectes* available for this study are more closely related to the members of the genus *Cambarus* than to those members of the genera *Procambarus* and *Pacifastacus* listed in Table I.

[2]Sera from O.nais, O.immunis, and P.trowbridgii were kindly supplied by Dr. Charles A. Leone, University of Kansas, Lawrence, Kansas.

TABLE I. SEROLOGICAL COMPARISONS AMONG CRAYFISHES[1]

ANTIGENS	*C.b.bartonii*	*C.b.robustus*	*C.b.sciotensis*	*C.m. acuminatus* (a)	*C.m.acuminatus* (b)	*C.l.longulus*	*Cambarus* sp.	*O.juvenilis*
Cambarus								
C.b.bartonii	100	93	82	95	92	85	86	73
C.b.robustus	88	100	83	84	94	95	81	74
C.b.sciotensis	93	98	100	82	97	93	90	90
*C.b.*subsp.	85	95	81	87°	97		83	85
C.m.acuminatus	78	97	82	100	100	86	84	68
C.l.longulus	84	90	84	66°	91	100	100	81
C.l.longirostris	86	92			93	87		78
Cambarus sp.	85	90	75	75	95	87	100	79
Orconectes								
O.juvenilis	57	79	68°	54°	65		85°	100
O.immunis	57°	76	69°	49°			89	
O.nais	44	77			59			82
O.p.propinquus	57	78			63			98
Procambarus								
P.b.acutus	51°	65			53			63
P.clarkii	47°	64			45			60
Pacifastacus								
P.trowbridgii	60°	89			62			65

[1]The numbers represent the mean percent of the homologous test (100). An asterisk indicates that the test was run only once. The standard deviation for these mean percent values may be obtained by writing to the author.

CONCLUSION.— The members of the genus *Cambarus* utilized in this study are very closely related serologically and, due to unsatisfactory specificity of the antisera prepared, cannot be significantly distinguished by this technique. Johnson (1957) states that *C.m.acuminatus* (Montanus group) appears to be serologically identical to the members of the Bartonii group using the agar diffusion method of Elek. Results of the present tests would tend to substantiate this conclusion as the antiserum (a), prepared against *C.m.acuminatus* in column four of Table I indicates a slightly closer affinity with the members of the Bartonii group than with those of the Longulus group. It may be of interest that antiserum (a) was used in the agar diffusion tests, whereas, antiserum (b) prepared against the

same subspecies was developed after the agar diffusion studies were completed.

It is doubtful whether the members of the Longulus group can be separated from the members of the Bartonii and Montanus groups with the data from the antisera used. Perhaps by absorption of the antisera, using the antigens of other closely related Crustacea, greater serological differences could be demonstrated among members of the genus *Cambarus*. Until this can be done, the present taxonomic affinities of this group, based on morphology, biogeography and ecology, cannot be disputed.

Significant serological differences are demonstrated between these members of the genus *Cambarus* and members of the other genera compared (*Orconectes*, *Procambarus*, and *Pacifastacus*) substantiating the usefulness of this technique in making intergeneric serological comparisons.

SUMMARY

The Libby Photronreflectometer was used in measuring the turbidities in a series of tube precipitation tests.

Antisera were prepared against the sera of six members of the genus *Cambarus*. and one member of the genus *Orconectes*. Each antiserum was tested with its homologous antigen and various heterologous antigens (Table I).

Significant serological differences were noted between the members of the genus *Cambarus* and those members of the genera *Orconectes*, *Procambarus*, and *Pacifastacus* utilized but could not be demonstrated within the three groups of the genus *Cambarus*.

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THE IN VITRO EFFECTS OF X-RADIATION ON HUMAN WHITE BLOOD CELLS

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One of the most consistant alterations which occurs in animals exposed to moderate doses of ionizing radiation is the marked decline in circulating leucocytes. This decline may be attributed to radiation damage of the hemopoietic system rather than direct effects on circulating cells (Cronkite and Brecher, 1955). Nonetheless changes in motility and phagocytic activity of circulating cells have been indicated *in vivo* following whole body x-irradiation (Fishman and Shechmeister, 1955, Shechmeister and Fishman, 1955.

The question then arises of the sensitivity of the various leucocyte types to *in vitro* ionizing irradiation. Lymphocytes have been shown to be quite sensitive to *in vitro* x-radiation (Schrek, 1946a, Patt et. al. 1952). Results of studies with granulocytes, however, vary from no effect following 600 r (Hiramatsu and Okamoto, 1948) and enzyme alteration following 50,000 r (Wagner, et.al. 1957). In the present study, use is made of recent advances in leucocyte isolation (Skoog and Beck, 1956) to investigate the sensitivity of leucocyte type, the neutrophil, to x-radiation. Attempts were made to modify the radiation effects using glutathione, ethylenediaminetetraacetic acid, and reduced temperature.

METHODS.—Venous blood from healthy human volunteer donors was heparinized (0.4 mg per ml) and mixed with dextran[2] (one percent final concentration for thirty minutes to speed red cell sedimentation. The leucocytes were harvested from the plasma by centrifugation at one hundred times g for fifteen minutes. The cells were washed twice in modified Hank's solution (McKinney et.al. 1953) and finally centrifuged in protein sedimentation tubes at eight to ten times g for thirty minutes or in fifteen ml centrifuge tubes at about 300 times g for ten seconds. Both methods resulted in actively motile cells and satisfactory red to white cell ratios (ranging from ten to 0.1 but usually near one). Cells were suspended finally in modified Hank's solution.

All glassware was cleaned with alcoholic potassium hydroxide,

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[2]The author wishes to thank Dr. George Brecher of The National Institutes of Health for the stock of ten percent salt-free dextran from Benger Laboratory, Ltd.

thoroughly rinsed, dried, and coated with G. E. Dri-Film. The coating was removed and replaced after each experiment. Hypodermic needles were coated with G. E. Dri-Bake.

X-irradiation was carried out in glass test tubes at room temperature. A total dose of 80,820 r was delived at a dose rate of 449 r per minute over a period of three hours using the inherent filtration of the machine (three mm aluminum) plus one mm aluminum. The cells were resuspended every thirty minutes. Total doses of 6,450 r, 12,900 r and 25,800 r were delivered at a dose rate of 215 r per minute using 0.25 mm copper and three mm aluminum added filtration. The x-radiation was delivered by a 250 Kvp, fifteen ma machine. Dose rates were determined with a Victoreen thimble chamber calibrated by the National Bureau of Standards.

Reduced glutathione (GSH) and ethylenediaminetetraacetate (EDTA) as the disodium salt were prepared in Hank's solution to give final concentrations of 10^{-3}M and 10^{-4}M, respectively The pH was adjusted to 7.4 with sodium hydroxide.

Following irradiation cells were incubated at 37°C and shaken 80 times per minute to keep them in suspension. Samples were removed to microscopic slides at intervals following irradiation and scored under oil immersion phase microscopy for the number of motile neutrophils per 100 neutrophils counted. In all instances, non-irradiated samples were run under the same conditions as the irradiated samples. Where possible, the tubes containing the cells were randomized so that the observer could not tell which sample was being counted.

RESULTS.—The first observable morphological alteration following x-irradiation was partial sphering of the neutrophil with a continuation of a pseudopodia formation. Upon contact with the slide, cells in this condition spread out and continued to form pseudopodia although not always in a definite direction. Nuclei and cytoplasmic viscosity as indicated by Brownian movement appeared normal. The next morphological change appeared in cells taken at a longer interval following irradiation. These cells remained spherical and exhibited no pseudopod formation. Such cells would stick to the surface of the slide but, in general, tended not to spread out. The nuclei still appeared normal, but the cytoplasmic viscosity was increased as indicated by decreased Brownian movement. None of these effects was apparent immediately after irradiation but were noted in 50 per cent of the cells four hours after the highest x-ray dose. The same series of changes were observed in non-irradiated preparations aged ten to fourteen hours.

The neutrophils displayed remarkable resistance to x-radiation as may be seen in figure 1a where motility is plotted as a function of dose. With an x-radiation dose of 80,820 r, the mean percent motility of neutrophils in Hank's solution was reduced only 53 percent of the controls at four hours after the radiation. The dose-effect curve was exponential at the lower doses

but tended to flatten out at the highest dose (fig. 1a).

An attempt was made to modify the effects of x-radiation on neutrophil motility by the addition prior to irradiation of glutathione or EDTA, both of which are agents shown to offer protection against ionizing radiations (Barron et. al, 1949. Bacq and Alexander, 1955). Samples of cells with Hank's solution alone, with Hank's solution plus glutathione, and with Hank's solution plus EDTA were given 80,820 r, a dose which caused appreciable effects on cell motility (see fig. 1a). The results are shown in table 1. Although the variation was large because of the long irradiation time necessary to accumulate 80,820 r (three hours), the radiation protection by glutathione was evident. EDTA proved to be toxic to the cells

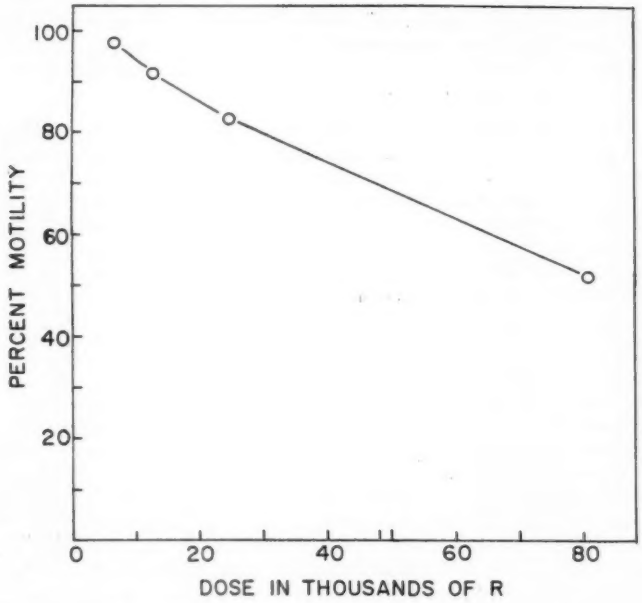

Fig. 1a. Dose effect curve for neutrophil motility. The percent motility was determined four hours after the end of the x-irradiation. The percent motility was determined as $\frac{n}{n_o} \times 100$ where n was the number of motile neutrophils from the irradiated sample and n_o was the number of motile neutrophils from the non-irradiated sample.

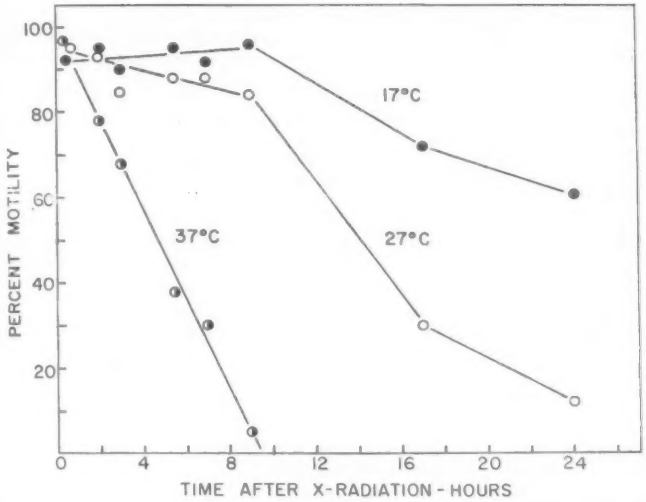

Fig. 1b. Effect of temperature on x-radiation induced inhibition of neutrophil motility. Dose, 80,820 r. Percent motility was determined as in 1a.

such that the motility of the non-irradiated cells with EDTA was significantly lower than the motility of the non irradiated cells in Hank's solution alone after four hours incubation. However, there was no increase in damage to cell motility attributable to x-irradiation.

Protection by post-irradiation incubation at lowered temperatures is firmly established for x-irradiation (Schrek, 1946b, Stapleton et. al. 1953). Reduced incubation temperatures were found to decrease the effect of x-irradiation on neutrophil motility as indicated by the persistence of motility for a longer time in the irradiated cells (fig. 1b).

DISCUSSION.—Neutrophils, despite their susceptibilty to other types of injury (Martin et. al. 1955), exhibited a marked resistance to x-irradiation, the dose required for neutrophil immobilization being about 80 times that required for lethality of lymphocytes (Schrek, 1946a). A consideration of the two factors which would contribute to this resistance. First is the inability, or at most limited ability, of leucocytes to synthesize deoxyribonucleic acid (Winzler, 1957, Kline and Clifton, 1952), an activity shown to be sensitive to x-radiation in other cells. Bacq and Alexander, 1955). A second factor is suggested from the demonstration that glutathione protected neutrophils from x-radiation. Since reduced sulfhydryl groups, in

Treatment	No x-radiation	80,820r x-radiation	P
Control	63 ± 17 (5)	40 ± 20 (6)	0.001
10^{-3}M GSH	55 ± 17 (5)	53 ± 19 (6)	0.3
10^{-4}M EDTA	35 ± 24 (6)	35 ± 13 (6)	0.8

TABLE 1.—Effect of GSH and EDTA on x-radiation induced inhibition of neutrophil motility. Data are expressed as motile neutrophils per 100 neutrophils counted, with standard deviations. Number of experiments given in parentheses. The X_2 method was used to test the difference between the motility of non-irradiated and irradiated samples. P indicates the probability that this difference could occur by chance alone. P values smaller than 0.01 are regarded as statistically significant.

general, afford protection against ionizing radiations (Barron et. al. 1949, Patt et. al. 1952), the normally high content of reduced sulfhydryl groups in leucocytes (Green and Martin, 1955, Hardin et. al. 1954) would be consistant with decreased radiation sensitivity.

The similarity between the morphological changes which appeared shortly after x-radiation and those which appeared in non-irradiated cells aged about twelve hours would suggest that immobilization and eventual cell death in both cases were attributable to the same, or similar, mechanisms. Certain observations made here offer some basis for speculation about this similarity as well as the sites or radiation damage. First, the protection of neutrophils by lowered temperatures and by reduced glutathione implicates the metabolism of the cell in radiation induced immobilization (see Barron et. al. 1949, Stapleton et. al. 1953). Support for this comes from the demonstration of a decreased enzyme activity in leucocytes as manifest by reduced oxygen consumption following 50,000 r (Wagner et. al. 1957). The contribution of enzyme alteration to cell immobilization cannot be evaluated, however, without more study directed specifically toward this interrelation. Second, the morphological change from a flattened amoeboid cell to a sphere, i.e., increased volume with a reduction in surface-volume ratio, most probably results from an alteration in cell permeability prior to immobilization. Precedent for this type of alteration may be found in the work of Sheppard and Stewart (1952) where x-radiation induced permeability changes in erythrocytes were demonstrated. It has also been shown that leucocyte permeability, at least to potassium, increases with aging particularly when the cells are shaken as in the present experiments (Hempling 1952).

A point which must be kept in mind is the possibility that cell immobilization is a terminal event, the causes of which are varied. In view

of this, it may not be profitable to seek one site of radiation damage in neutrophils. Rather it is more likely that enzyme damage and membrane alteration are but two of several factors which contribute to x-radiation induced immobilization in these cells.

SUMMARY

1. Supensions of human neutrophils in Hank's solution were found to be quiet resistant to x-irradiation using cell motility as a criterion of effect. Morphological changes noted in the neutrophils following radiation were similar to changes noted in aged cell preparations.

2. Glutathione offered some protection against the effects of x-radiation.

3. Reduced incubation temperatures following x-irradiation offered striking protection against the radiation effects.

4. The results are consistent with radiation damage to enzyme systems and to the cell membrane prior to immobilization.

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News And Notes

(Editor's Note). News contributions should be sent to the person whose name appears at the end of the appropriate sections.)

MINUTES OF THE COUNCIL MEETING

Newcomb Hall, Charlottesville
March 8, 1959

The meeting was held in Newcomb Hall at the University of Virginia. Dr. Forbes, Academy President, called the meeting to order at 10:45 a.m. He had invited the Section Chairmen or their designate to attend this meeting. Those present were:

J. C. Forbes; William G. Guy; William M. Hinton; Horton H. Hobbs, Jr.; Harry G. M. Jopson; George W. Jeffers; William Scott; Robert T. Brumfield; Robert H. Brownson; James W. Cole; Paul M. Patterson; William G. Lowry; Jacques Rappaport; S. P. Maroney, Jr.; Sidney S. Negus; Thelma C. Heatwole; J. C. Holmes; S. S. Obenshain; John T. Hack; Foley F. Smith; and William B. Wartman, Jr.

It was moved and passed that the reading of the minutes of the October 1958 meeting be omitted since they were printed in the Journal.

OLD BUSINESS

Treasurer's Report: The Treasurer's report included the proposed budget and a statement of the estimated income for 1959. The estimated income is about $400.00 in excess of the proposed expenditures and the balance in the General Fund on January 1, 1959 was $5,433.60. It was moved and passed that the Treasurer's report be accepted.

The Treasurer read a portion of the minutes of the Finance and Endowment Committee pertaining to the raising of $1500.00 additional income. It was pointed out that since the estimated income for 1959 exceeds the proposed budget, there was no urgent need for recommending means of raising additional income. Finance Committee members were urged, through personal contacts, to assist the Business Membership Committee in increasing the Business Members in the Academy.

The Finance Committee recommended that Council request the Trustees to invest $3,000,.00 of the approximately $5,000.00 balance in the General Fund. This is to be invested in some short-term earning capacity. This was approved by Council.

Funds for Study of Results of Science Talent Search: Mr. Joseph Holmes, Chairman of the Science Talent Search Committee, reported that requests for funds from the National Science Foundation, the Ford Foundation and the Old Dominion Foundation had not met with any success. He suggested

that since this is a local state project, that it may be best to seek funds within the state. Dr. Jeffers suggested that Dr. Lowry of the University of Virginia be consulted as the possibility of this study being undertaken by a graduate student in the School of Education.

Institute for Prospective College Seniors and Their College Teachers: Dr. Forbes briefly reviewed this proposal. A grant has been requested from the National Science Foundation to support this program.

Proposed Program for the Improvement of Science Teaching in the Colleges of Virginia: A joint application by the Virginia Academy of Science and the University Center in Virginia for funds to support this program has been submitted to the National Science Foundation. This proposal was discussed briefly by Dr. Forbes.

Status of the Dismal Swamp Project: Dr. Forbes reported that Dr. Baldwin was unable to attend the meeting. Dr. Baldwin will write the History Section and he feels that the Geology Section needs some revision. Dr. Hack reported that nothing new on the geology of the Dismal Swamp has been written for some time. This will be discussed in the Geology Section at the May meeting.

NEW BUSINESS

Report of the Virginia Journal of Sciences Dr. Brumfield reported that Dr. Lane was unable to be present, and that this was an interim report. A new printing contract at the present rate has been arranged with the present printer, whose bid was low. Economies previously discussed have been effected, and this has resulted in reducing the annual Journal deficit occurring in recent years. This deficit is due to increase in printing and other expenses, without increase in revenue. The Journal is still operating at an annual loss of about $1000.00 The present balance is about $3,000.00. Dr. Brumfield requested that invitational papers be submitted.

Report of Local Committee on Arrangements: Dr. Maroney reported that the program had been submitted to the Virginia Journal of Science for publication in the April issue. Contracts for thirteen commercial exhibits have already been made.

Dr. Rappaport reported on the housing arrangements. He recommended that members make housing reservations as early as possible. The gymnasium will have accommodations for about 100 students.

Programs for Junior Academy Members: Mrs. Heatwole proposed that the Junior Academy be allowed to charge a 25c Registration Fee to cover the cost of programs for the May meeting. It was felt that this would encourage Junior members to attend section meetings. It was moved and passed that the Junior Academy be allowed to charge 25c Registration Fee to cover the cost of a program, this fee to be turned over to the Treasurer of the Senior

Academy. It was suggested that 200 additional programs be printed for this purpose.

Report of Science Talent Search Committee: J. C. Holmes, Chairman, reported that there were eight students from Virginia who received "Honorable Mention" in the National Talent Search, which is the best record in recent years.

The Committee is concerned since there are many sections in the state which rarely or never participate in the Science Talent Search. As one possible approach to encouraging statewide participation in this program, they suggested that 100 high school science teachers, who are outstanding graduates of Virginia colleges, be written and urged to encourage students to pursue scientific careers and participate in Science Day meetings: The Committee requested Council to consider this and other possible means of increasing the participation in the Science Talent Search especially in those sections of the state which are not now active in the program.

Dr. Forbes requested Council members to consider this matter, and it is hoped that additional recommendations be brought up at the May meeting.

Goethe Award: Each year the Academy is the grateful recipient of a liberal contribution by Dr. C. M. Goethe, who has requested that the Academy advise him as to how this contribution can best be used. It was decided that $50.00 of this contribution be designated the Goethe Award and that it be awarded each year to married graduate students, preferably with at least two children, to help defray their expenses to the annual Academy meeting in May. Dr. Goethe is to be advised of this action.

Dr. W. W. Scott of the Virgina Polytechnic Institute will select the two recipients of the Goethe Award for the 1959 Academy meeting.

Mrs. Heatwole reported that the Junior Academy is considering the establishment of a traveling library and asked if this action would have to be approved by Council. She was advised that Council approval was necessary.

Dr. Forbes thanked the section Chairmen for attending and participating in the discussions. With regret, he reported that Dr. Ralph Bradley had accepted a faculty position at the University of Florida and was therefore resigning from the Council. A member to replace Dr. Bradley will be elected at the May meeting.

The meeting was adjourned at 7:15 p.m.

— P. M. Patterson

AGRICULTURAL SCIENCE

Dr. Leonard W. Feddema has been appointed Associate Professor of Horticulture at the Virginia Polytechnic Institute effective July 1, 1959.

Dr. Feddema will serve as Extension Vegetable Specialist in the position formely held by L. C. Beamer, who retired on March 31, 1959.

The National Institutes of Health has awarded a research grant for the study of the inheritance of resistance to insecticides in the German cockroach to Dr. D. G. Cochran, Associate Professor of Entomology, and Dr. J. M. Grayson, Professor of Entomology in the amount of $6,633 for the first year and for a total of $16,256 for a three-year period.

The National Institutes of Health has awarded a research grant for the study of insects as vectors of infectious synovitis in poultry to Dr. E. M. Raffensperger, Associate Professor of Entomology, and Dr. J. W. Davis, Professor of Animal Pathology in the amount of $8,286 for the first year and a total of $29,124 for a four-year period.

Mr. Monte E. Juillerat has been appointed Assistant Professor of the Virginia Polytechnic Institute. He is a native of Columbia City, Indiana with his M. S. from Purdue University and completed requirements for his Ph. D. at Purdue University. He will work initially in the area of livestock marketing research in the Department of Agricultural Economics.

The Nutrition Foundation, Inc., New York, New York, has announced renewal of its grant in the amount of $12,000 for the next three years to Dr. Russell Miller and Dr. R. W. Engel, Department of Biochemistry and Nutrition of the Virginia Polytechnic Institute. This grant continues support of studies of the biochemical and physiological role of dietary molybdenum, sulfate, and copper in animals. Of special interest is the influence of molybdenum feeding on selected enzyme systems and upon certain physiological abnormalities. Molybdenum toxicity conditions are found in many areas of the world in grazing animals consuming grasses naturally high in molybdenum.

The National Institutes of Health have awarded Dr. C. J. Ackerman, Department of Biochemistry and Nutrition of the Virginia Polytechnic Institute, $12,755 for the next three years to continue present studies upon the biochemical, chemical and physiological effects of ethylene oxide fumigation and treatment of proteins and amino acids. To be emphasized will be studies to determine the effect of ethylene oxide upon selected enzyme systems. Ethylene oxide has been used commercially as a cold sterilization agent for some food stuffs.

Dr. Russell Miller, Associate Professor, Department of Biochemistry and Nutrition, talked to the Virginia Military Institute student affiliates of the American Chemical Society on Wednesday, April 22. The talk developed the history of biochemistry and emphasized the many and varied research problems currently being worked upon by staff and graduate students at the Virginia Polytechnic Institute.

The Virginia Polytechnic Institute contributed in unprecedented force

to the annual meetings of the Federation of American Societies for Experimental Biology in Atlantic City in April which brought together over 10,000 scientists from all over the world. Three research reports and one symposium paper ware presented by members of the staff of the Departments of Biochemistry and Nutrition and of Biology. Drs. C. J. Ackerman (Bio. N.), W. A. Hardison (Dairy Science), and K. W. King ('49, Biol.) were elected to membership in the American Institute of Nutrition. A group of nineteen Tech alumni and staff got tegether for a Virginia Polytechnic Institute dinner, including Dr. J. W. Gill (Ph.D., V.P.I., 1957, now at the University of New Hampshire, Durham, New Hampshire), Dr. J. H. Hash (Ph.D., V.P.I., 1956, now with Bowman-Gray Medical School, Winston-Salem, North Carolina), Lt. Brendan E. Joyce (M.S., V.P.I., 1955, from Army Medical Training School, Fort Sam Houston, Texas), and Dr. H. G. Windmueller (Ph.D., V.P.I., 1958, now at Brandeis University, Boston, Massachusetts).

James F. Eheart ('19), Associate Biochemist, Virginia Agricultural Experiment Station, was elected Chairman of the Southern Pesticide Residue Cooperative Research Group at a recent meeting in Fayetteville, Arkansas This group consists of workers from eight Southern states, Puerto Rico, and the United States Department of Agriculture.

Dr. Grant Thomas, Assistant Professor of Agronomy at the Virginia Polytechnic Institute attended a four week course at Oak Ridge on the use of tracer techniques as a research tool.

Professor J. A. Schad, State president of the newly organized Industrial Arts Association in Virginia, represented the Virginia Polytechnic Institute and the State at the annual convention of the American Industrial Arts Association in Long Beach, California, April 22-25. Professor Schad is head of Industrial Arts Education in the department of Vocational Education, Virginia Polytechnic Institute.

Dr. Harry Huffman, Head of Business Education, was awarded a plaque by the Roanoke Chapter of the National Office Management Association "in recognition of achievement in training for business". This is the first time that such recognition was made by the Roanoke Chapter of NOMA. Dr. Huffman was also a recent teacher and consultant at several out of state meetings including Phoenix, Arizona and Long Beach, California. On the same trip he also visited business education departments and participated in discussion groups at San Diego, Los Angeles, San Francisco, San Jose, and Sacramento, California.

Recently off the press is *The Clerical Program in Business Education* This publication is the sixteenth American Business Education yearbook. Dr. Harry Huffman and Professor Jeffery R. Stewart, Jr., both of the Business Education staff, the Virginia Polytechnic Institute, are editor and associate editor respectively. The 470 page volume contains material that

will be used by Business educators for many years to come.

The staff of the Department of Agricultural Education of Ohio State University were guests of Dr. T. J. Horne and his staff in Agricultural Education at the Virginia Polytechnic Institute on May 11 and 12. The visitors made an intensive study of the plans, program, organization, and accomplishments of the local department and observed the work of several departments of vocational agriculture in the Southwest Virginia area.

ASTRONOMY, MATHEMATICS, AND PHYSICS

Dr. T. M. Hahn, Jr., Head of the Department of Physics at the Virginia Polytechnic Institute, has accepted the position of Dean of the College of Arts and Sciences at Kansas State University. No successor has yet been appointed.

The new Physics building at the Virginia Polytechnic Institute is now under construction, with the installation of the 10 KW reactor scheduled for the fall. The building will be in use by January 1960.

Dr. Bruno Alter, comes to Randolph-Macon Woman's College as acting chairman of the Physics Department this fall. He holds the Ph. D. degree from Lehigh and is presently on the faculty of Vanderbilt University.

The Univeristy of Virginia will offer an NSF Institute for high school teachers again this summer. Dr. F. L. Brown of the University of Virginia and Dr. T. E. Gilmer of Hampden-Sydney will teach the physics group.

Several colleges within the state took advantage of the Visiting Scientist Program of the AIP during this past year. Among them were the Virginia Military Institute, the University of Richmond and the Virginia Polytechnic Institute.

W. W. Walker will join the staff at the college of William and Mary as assistant Professor of Physics this fall. Dr. Walker recently received his Ph.D. at the University of Virginia.

In the fall of this year, the college of William and Mary will reactivate the Master's program in Physics.

Dr. Stephan Berko returns in September to the University of Virginia. He has been working at the University of Copenhagen as a Sloan Fellow.

Dr. S. W. Mitchell, well known solid state physicist of Great Britain, will become a permanent member of the physics faculty at the University of Virginia, this fall. Dr. Mitchell, a native New Zealander, is a Fellow of the the Royal Society and has been honored for his work in many ways.

Richard E. Grove, professor of Physics at Randolph-Macon College, will receive his Ph.D from Syracuse this June.

Dr. E. T. S. Walton, Nobel prizewinner in 1951, gave a series of

lectures at Randolph-Macon this spring. This was his first stop in a tour of the United States.

Dr. Harold Alden, University of Virginia astronomer, will attend the Second Astrometric Conference May 17-20. This Conference, supported by the NSF, is devoted to the creation of more interest in the determination of fundamental star positions.

—I. G. Foster,
Virginia Military Institute

BACTERIOLOGY

The award established by the Virginia Branch of the Society of American Bacteriologists for an outstanding contribution to the Science Fair was presented at the annual meeting of the Virginia Academy of Science: First Prize ($25.00 and a certificate)—William Ridenour, winning the reward for a second time, (sponsored by Mrs. R. B. Painter) of the William Fleming High School, Roanoke, for "Comparison of Chemical and Radiological Mutation in *E. coli*"; Second Prize (Honorable Mention)—Barbara Sink (sponsored by Mr. C. W. Holhurt) of Boiling Springs High School, Covington, for "Incidence of *Candida albicans* in the Saliva of White Rats."

Dr. Quentin N. Myrvik presented a paper entitled "Serum and tissue lysozyme levels in rabbits undergoing a granulomatous reaction induced by BCG" at the International Symposium on Fleming's Lysozyme held the 3rd to 5th of April at Milan, Italy.

—P. Arne Hansen,
University of Maryland

BIOLOGY

Mr. T. H. Ma has completed his graduate work at the Blandy Experimental Farm and the University of Virginia, majoring in plant genetics, and has accepted a position in the Biology Department of Emory and Henry College. His new work started in June, 1959.

Dr. A. B. Massey, Professor of Botany, Virginia Polytechnic Institute, will retire at the end of the 1958-59 academic session. He will continue his work on the Flora of Virginia as Emeritus Professor of Botany and Curator of the Herbarium.

Dr. Jane Belcher of Sweet Briar College will be on sabbatical leave during 1959-60. Miss Belcher will visit Nigeria where she expects to do some work with certain amphibians. Miss Rose Mary Johnson, a candidate for the Ph.D. degree at the University of Virginia, will replace Miss Belcher during the latter's leave.

Dr. J. L. McHugh, Director of Virginia Fisheries Laboratory since 1951, has resigned to accept an appointment as Chief of the Division of

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Biological Research, Bureau of Fisheries, U. S. Fish and Wildlife Service. Dr. William J. Hargis has been appointed Acting Director of the Laboratory.

A. Randolph Shields, a candidate for the Ph.D. degree in botany at the University of Tennessee, has been appointed Assistant Professor of Biology at Roanoke College, effective September 1, 1959.

Dr. B. F. D. Runk, Professor of Biology at the University of Virginia, has been appointed Dean of the University, effective March 1, 1959.

President Colgate W. Darden, Jr. of the University of Virginia, recently announced that an anonymous donor has given over $500,000 to strengthen biology teaching and research at that institution. Simultaneously he announced that the National Institutes of Health will grant $612,000 for research facilities in the planned Life Science Building for which the General Assembly has appropriated two million dollars. Plans for the building are now well advanced and it is hoped that ground can be broken for the construction, late in 1959.

—Walter S. Flory, Jr.,
University of Virginia

CHEMISTRY

Miss Virginia Celeste Ellett, a chemistry teacher at Thomas Jefferson High School, Richmond, Virginia, was selected by the Virginia Section of the American Chemical Society to receive its Distinguished Service Award for the year 1959 for her outstanding contributions to science teaching and to the building of interest in secondary school science in Virginia. Miss Ellett was awarded the Hitchcock Prize and a scroll of merit at a dinner party given in her honor on June 5. Miss Ellett, a native Virginian, received her B. S. degree from Westhampton College and her M. Ed. degree from the University of Virginia. In 1951, she received a General Electric Fellowship in Chemistry and physics for work at Union College, Schenectady, New York. Miss Ellett has been an outstanding leader in secondary school science activities in the State. She has arranged a General Science Course which is being used by many teachers as a course of study. She has developed an Advanced Chemistry Course for high school students, which is being used as a model in other states. Because of Miss Ellett's efforts, many industrial organizations, including the du Pont Company, the Reynolds Metals Company, The American Tobacco Company, the Virginia Institute for Scientific Research, Philip Morris, Inc., and Experiment, Inc., are providing material assistance and even instructors to teach the students who are capable of doing college-level work in chemistry. Miss Ellett was awarded a Science Fellowship recently for teachers of advanced chemistry courses to attend the 1959 Summer Institute sponsored by the National Science Foundation at Bowdoin College. In June, she will participate in a

conference in Denver for teachers of Advanced Placement courses. She and some of her students recently attended the first Atomic Use Conference in Atlantic City, New Jersey. This Distinguished Service Award of the Virginia Section of the American Chemical Society is made possible annually by Mrs. Henry K. McConnell in memory of her husband, who for many years was a great leader in industrial chemistry in the South.

In recognition of his outstanding contributions to the advancement of science in the South, Mr. Edward Swain Harlow, Assistant Managing Director of Research, Department of Research and Development of the American Tobacco Company was selected to receive the 1959 Distinguished Service Award of the Virginia Section of the American Chemical Society. The award, a scroll of merit, was presented to Mr. Harlow at a dinner party given in his honor on June 5, Mr. Harlow native Virginian, graduated from John Marshall High School and received his B. S. degree from the University of Richmond. He served as an instructor in physics for two years while at the University. Mr. Harlow was previously employed by the Western Electric Company and by the Division of Chemistry of the Virginia Department of Agriculture. He was granted a leave of absence from The American Tobacco Company to serve in the U. S. Navy and during his tour of duty was awarded both the Navy commendation ribbon and the Bronze Star Medal. Mr. Harlow's Investigations in the fields of the composition of tobacco and tobacco smoke have resulted in the publication of numerous scientific papers. In addition to his responsibility for the expanding research program of The American Tobacco Company, Mr. Harlow's activities include membership on the Operating Committee of Industrial Reactor Laboratories, Inc., at Plainsboro, New Jersey. Full scale operation of the recently completed swimming pool type reactor is now anxiously awaited by the ten participating companies. He was closely associated with the construction and operation of the Radiological Nutriculture Laboratory, which was completed and presented to the Medical College of Virginia by The American Tobacco Compny in May, 1956. For several years, he has served as research associate in the Department of Pharmacology at the Medical College of Virginia and aids in the coordination of research on the pharmacological and physiological aspects of tobacco and tobacco smoke carired on under a research grant by The American Tobcco Company to the college. In addition, he assists in the administration of other fundamental research sponsored by the company at several institutions of higher learning and research institutes.

Dr. J. Samuel Gillespie, Jr., formerly an associate of Edwin Cox, Chemist and Chemical Engineer, Aylett, Virginia, has been made a partner in the new firm of Cox and Gillespie, Chemists and Chemical Engineers. The firm has opened a consulting office offering chemical and engineering services at 5 North Sixth Street, Richmond, Virginia, in addition to its Aylett facilities. Dr. Gillespie is a graduate of the Virginia Military Institute

and the University of Virginia. He was previously associated with the Virginia-Carolina Chemical Corporation and was Assistant Professor of Chemistry at the University of Richmond.

—Mearl A. Kise,
Virginia Smelting Company

ENGINEERING

Mr. Tilton E. Shelburne, Director of the Virginia Council of Highway Investigation and Research, attended a meeting of the Board of Directors of the American Society of Civil Engineers in Cleveland, Ohio in May. In April Mr. Shelburne attended the Advisory Committee meeting on the AASHO road test at LaSalle, Illinois and in May he was a member of the Performance Rating Panel on this road test. At the University of Virginia Mr. Shelburne was active in organizing the Soils Mechanics Conference which was held in March. Professor William Zuk of the Civil Engineering Department of the University attended the meeting of the Society of Experimental Stress Analysis in May.

Dean Lawrence R. Quarles of the Engineering School attended the Southwestern Regional meeting of the American Society for Engineering Education at Tuscaloosa, Alabama in April. As representative of Governor Almond he attended a meeting in Nashville, Tennessee in April of the Regional Advisory Council on Nuclear Energy. Professor Orville R. Harris of the Electrical Engineering Department of the University of Virginia Section of the Institute of Radio Engineers. He attended the annual meeting of the IRE in New York in March.

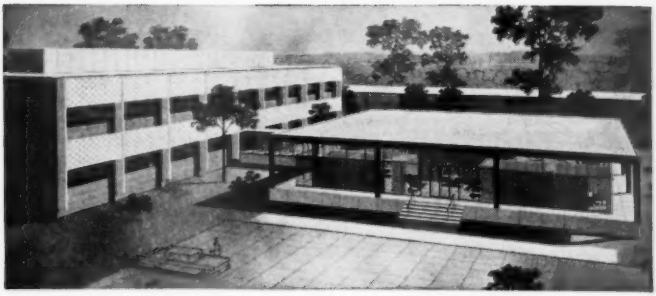
Professor Otis L. Updike of the Chemical Engineering Department of the University of Virginia was co-chairman for local arrangements of the Eastern Stimulation Council which held a meeting in Charlottesville in April. During the summer of 1959 Professor Updike will fill a research participation appointment in the Chemical Technology Division of the Oak Ridge National Laboratory in Oak Ridge, Tennessee.

Professor Robert W. Truitt of the Aeronautical Engineering Department of Virginia Polytechnic Institute has recently written a textbook "Hypersonic Aerodynamics" published by the Ronald Press Company. Professor A. C. Bruce, on leave of absence from the Aeronautical Engineering Department at Virginia Polytechnic Institute, has completed a year of graduate work toward the Ph.D. degree in Aeronautical Engineering at Massachusetts Institute of Technology.

—R. M. Hubbard,
University of Virginia

PSYCHOLOGY

John F. Hahn of the Psychology Laboratory, University of Virginia,



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The new laboratories and instrumentation will facilitate comprehensive studies into the basic nature of tobacco, smoke and smoke flavor as well as intensify our corporate research into packaging and adhesive materials.

We are looking forward to the achievements to come from the new laboratory complex. We sincerely believe our greater emphasis on fundamental research will be an important factor in the continued growth of both our company and the industries we serve.

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was elected President of the Psychology Section, Virginia Academy of Science, at the May 8 meeting. Other new officers were Robert A. Johnston, of the University of Richmond, Secretary-Treasurer, and Richard H. Henneman of the University of Virginia, Executive Committeeman.

Cletus Cole of Arlington, Virginia, assumed office as President for the current year for the Virginia Psychological Association. New officers elected at the meeting on May 9 were President Elect, Frank Finger of the University of Virginia, and Treasurer, William Dunn, Jr., of V. A. Hospital, Richmond.

Notes from the Annual Meeting: Our thanks and appreciation go to Ken Lloyd for making the program arrangements and seeing that the meeting ran smoothly. The banquet was a tremendous success thanks to Art Bachrach's effort ably abetted by ample liquid refreshments. The symposium on Training of Psychologists almost floundered in a welter of amiability in spite of Frank Finger's egging everyone on until Dick Henneman stepped into the breach, took potshots here and there, so that the conflict beween experimental and clinical psychology can be expected to burn brightly for another year. A nice little extra-curricular argument flared briefly at Tom Lahey's over the question of sterilization. This might be a program topic for some time in the future since individuals appear to be available who could participate with feeling.

Robbert Gibbey and Max Hutt have produced a new book "The Child: Development and Adjustment". The event occurred around the beginning of May; midwife was Allyn and Bacon, of Boston.

Hannah S. Davis of Lynchburg Training School and Hospital and Fred Lipschitz of Southside Area Guidance Clinic, Petersburg, both having successfully defended their dissertations in oral examination will receive their doctorates in June. Miss Davis will receive her degree from Columbia University, Teachers College; her thesis is entitled "Judgment of Intellectual Level from Various Features of the Rorschach, Including Vocabulary." Mr. Lipschitz will receive his degree from Adelphi University; his thesis is entitled "An Investigation of The Self Concept Systems and Reactions to Frustration of a Group of Process and Reactive Schizophrenics."

Florence Farley, Central State Hospital, Petersburg, announces a program of summer work experience for undergraduates interested in going into graduate preparation in psychology or other mental health professions. Four positions have been established to permit students to rotate through various hospitals of the Department in order to become acquainted with the functions of these departments in the diagnosis and treatment of mental illness, to observe and work with patients suffering from various sorts of mental illness, and to leave the experience with a positive attitude toward mental illness and a desire to enter one of the professions in this field.

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SIXTH AT BYRD STREET

Richmond, Virginia

McGuire V. A. Hospital in Richmond hopes to establish a similar program.

E. Ray Harcom of William and Mary has received a $15,000 grant from NIMH which he will share with H. R. Blackwell of Ohio State Research Foundation to study certain factors possibly underlying reading disability. This study will last two years.

—Penelope Lewis,
Western State Hospital

STATISTICS

Effective September 1, 1959, R. A. Bradley will leave the Department of Statistics at the Virginia Polytechnic Institute to become chairman of the new Department of Statistics being formed at the Florida State University, Tallahassee, Florida. He has also been named representative on the Division of Mathematics of the National Research Council of the Eastern North American Region of the Biometric Society.

Boyd Harshbarger attended the Third Exploratory Conference on Missile Model Design for Reliabilty Prediction at the White Sands Proving Ground in April. He also attended the undergraduate training program at the Medical College of Virginia.

The American Statistical Association index for volumes 35-50 which has been a two-year project under the auspices of the Virginia Polytechnic Institute Department of Statistics has been submitted to the American Statistical Association. The editors of this volume are Charles Clunies-Ross, William A. Glenn, and Leroy S. Brenna.

Clyde Y. Kramer of the Department of Statistics was one of the instructors giving a short course on design of experiments at Perdue University from June 9-19.

Five of the students studying under the National Institutes of Health Training Grant at the Department of Statistics are spending the summer at the Medical College of Virginia.

John Bartko and James Kent began their graduate programs in statistics at the Virginia Polytechnic Institute in March 1959.

—Clyde Y. Kramer,
Virginia Polytechnic Institute